

DIRECTIONAL ASYMMETRY IN FEMALE AVIAN GONADS

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1. INTRODUCTION

BACKGROUND

Vertebrates' left-right body axis

Involve left-right symmetry breaking mechanisms & asymmetry generation

Three types of left-right asymmetry:

- Fluctuating asymmetry
- Antisymmetry
- Directional asymmetry**

Birds' directional asymmetry

Asymmetric development of female's reproductive tract with only a left reproductive ovary and oviduct

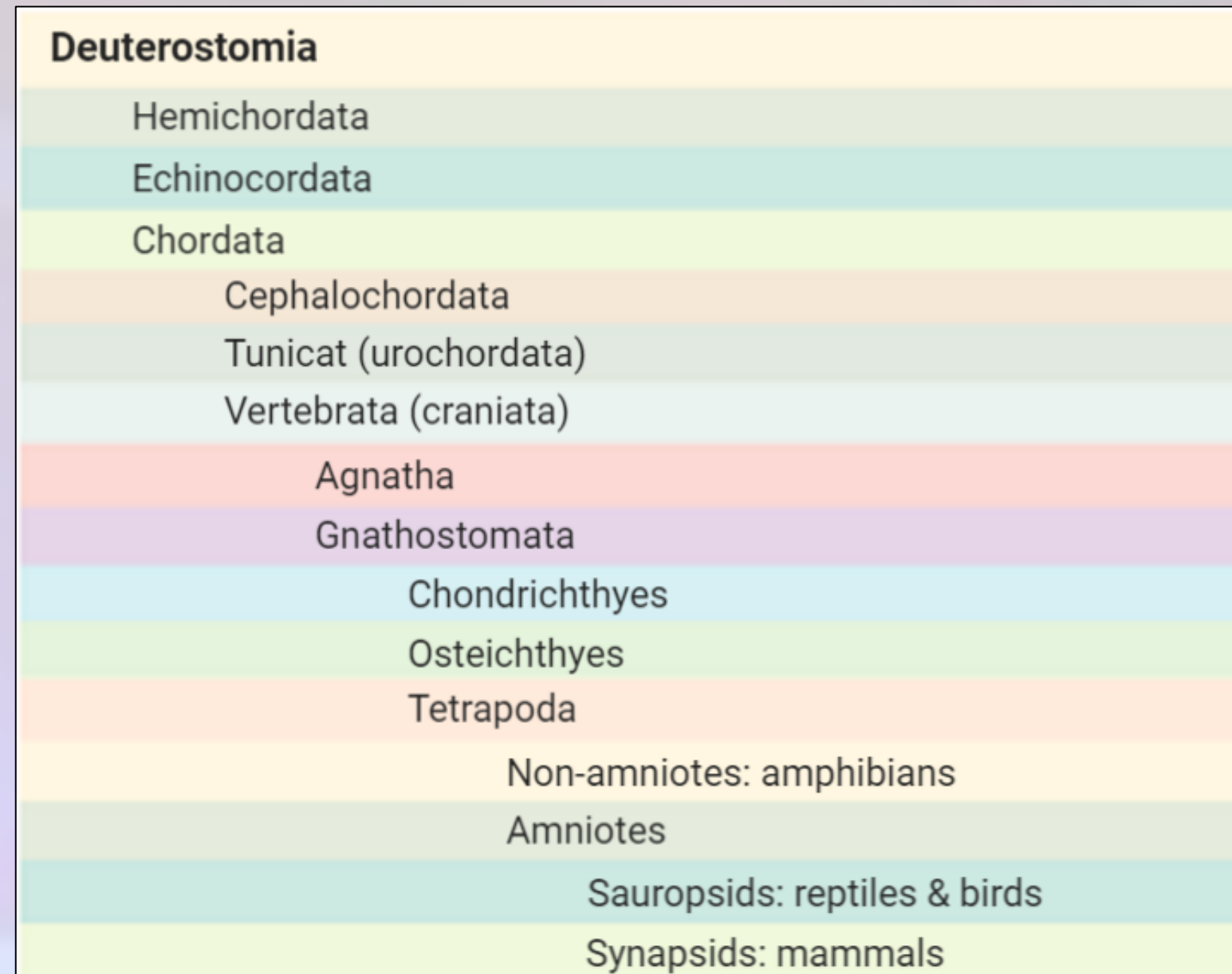


Figure 1. Deuterostomia classification

PROJECT'S OBJECTIVES

- Identify the embryonic stage when reproductive asymmetry is established.
- Describe ovarian asymmetry function.
- Investigate if natural reversals are possible.
- Determine if secondary characters are related to gonadal asymmetry.
- Identify genes involved in the gonadal directional asymmetry development.

2. METHODS

RESEARCH SURFACES

- Mendeley
- Science Direct
- "UAB Biblioteques"
- Google Scholar
- PubMed

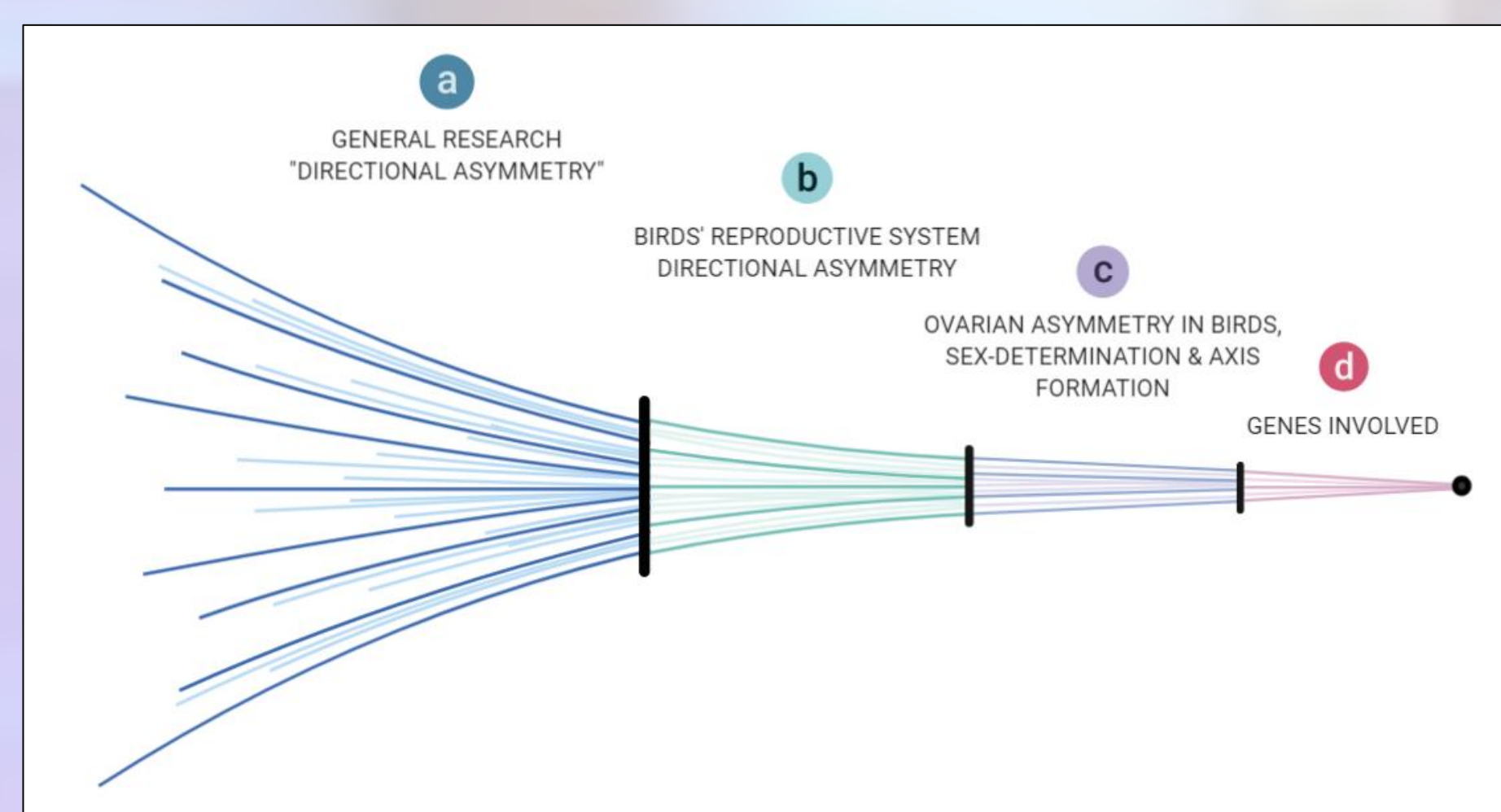
RESEARCH STRATEGY

- Boolean structures
- Stepwise process

KEYWORDS

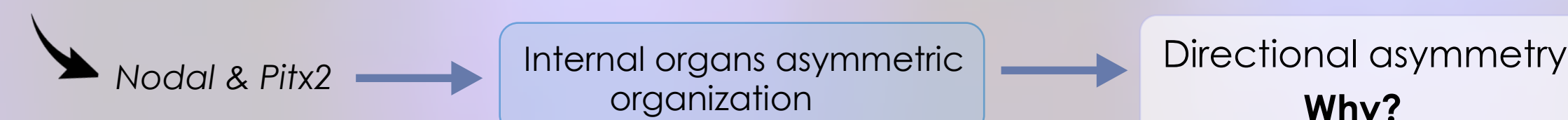
- "Left-right asymmetry"
- "Avian" & "Birds"
- "Gonadal development"
- "Ovary asymmetry"

Figure 2. Scheme representing the research stepwise process



4. DISCUSSION & CONCLUSION

Birds left-right axis establishment



Birds' ovarian directional asymmetric development

- First observation at stage HH28
- Differential gene expression

LEFT-SPECIFIC

Cell proliferation & pluripotency

RIGHT-SPECIFIC

Meiosis arrest & apoptosis

FUNCTION HYPOTHESES

- Space constraints
- Weight reduction (fly)
- Higher survival rate**

REVERSAL & SECONDARY SEXUAL TRAITS

- "Back-up" right ovary function
- Hormonal regulation of secondary sexual traits

DEVELOPMENT HYPOTHESES

- Other vertebrates avoid reproductive asymmetry
- Female birds potentiate reproductive tract asymmetries

CONCLUSIONS

Ovarian asymmetric growth

- Related to sex-determination
- Mediated by coding & non-coding genes

Functional left ovary & right gonad regression

Further studies are needed to fully understand the process

3. RESULTS

3.1. Embryonic development and body asymmetries

Germinal crescent

- Non-embryonic
- Containing PGCs

Axis

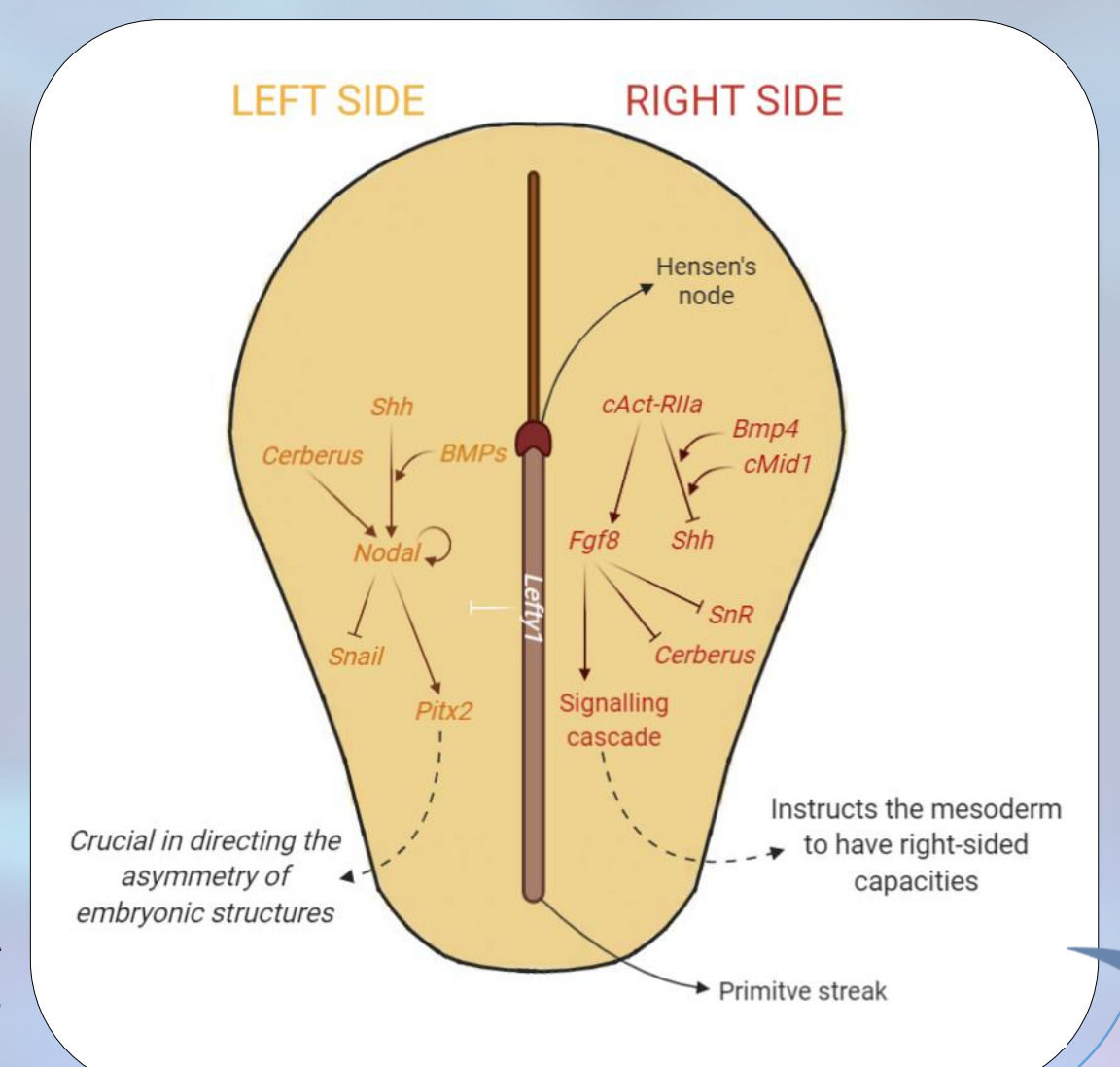
- Anterior-posterior
- Dorsal-ventral
- Left-right

Left side: Shh, Nodal & Pitx2

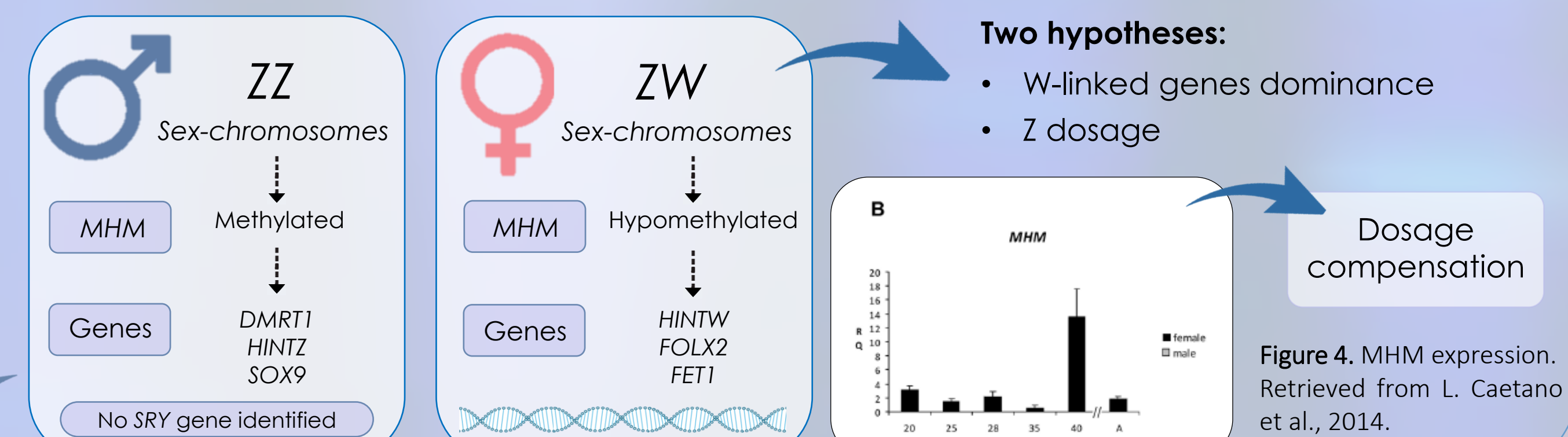
Right side: cAct-Rita & Fgf8

Midline: Lefty1

Figure 3. Gene expression during L-R axis establishment. Adapted from A. Raya and J. Izpisua Belmonte, 2004.



3.2. Birds' sex determination



3.3. Gonadal asymmetry

3.3.1. Gonadal development and asymmetric structure

Symmetric development until stage HH28

Ovaries layers

- Cortex
 - Asymmetric
- Medulla
 - Symmetric

PGCs

- Blood vessels by diaporesis
- Migrate via bloodstream
- Chemoattractant influence

Higher levels and proliferation of PGCs in the left gonad

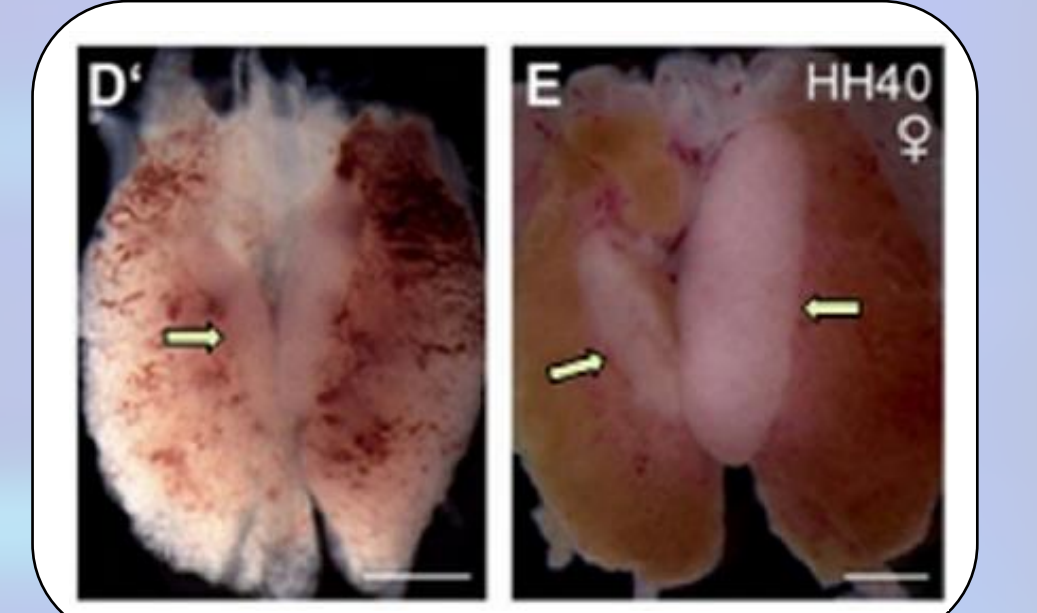


Figure 5. (D') Undifferentiated gonads (HH35). (E) Differentiated female gonads (HH40). Retrieved from L. Caetano et al., 2014.

3.3.2. Related genes

Asymmetric gene expression

- Most in autosome chromosomes

Estrogens' important role in ovarian development

Expressed in both gonads but its receptor (ER-α) is left-specific

MORE IMPORTANT REGULATORS

- Apoptotic & cell proliferation genes
- Ovex1**: endogenous retrovirus highly expressed in the left gonad
- MicroRNAs
- Long non-coding RNAs

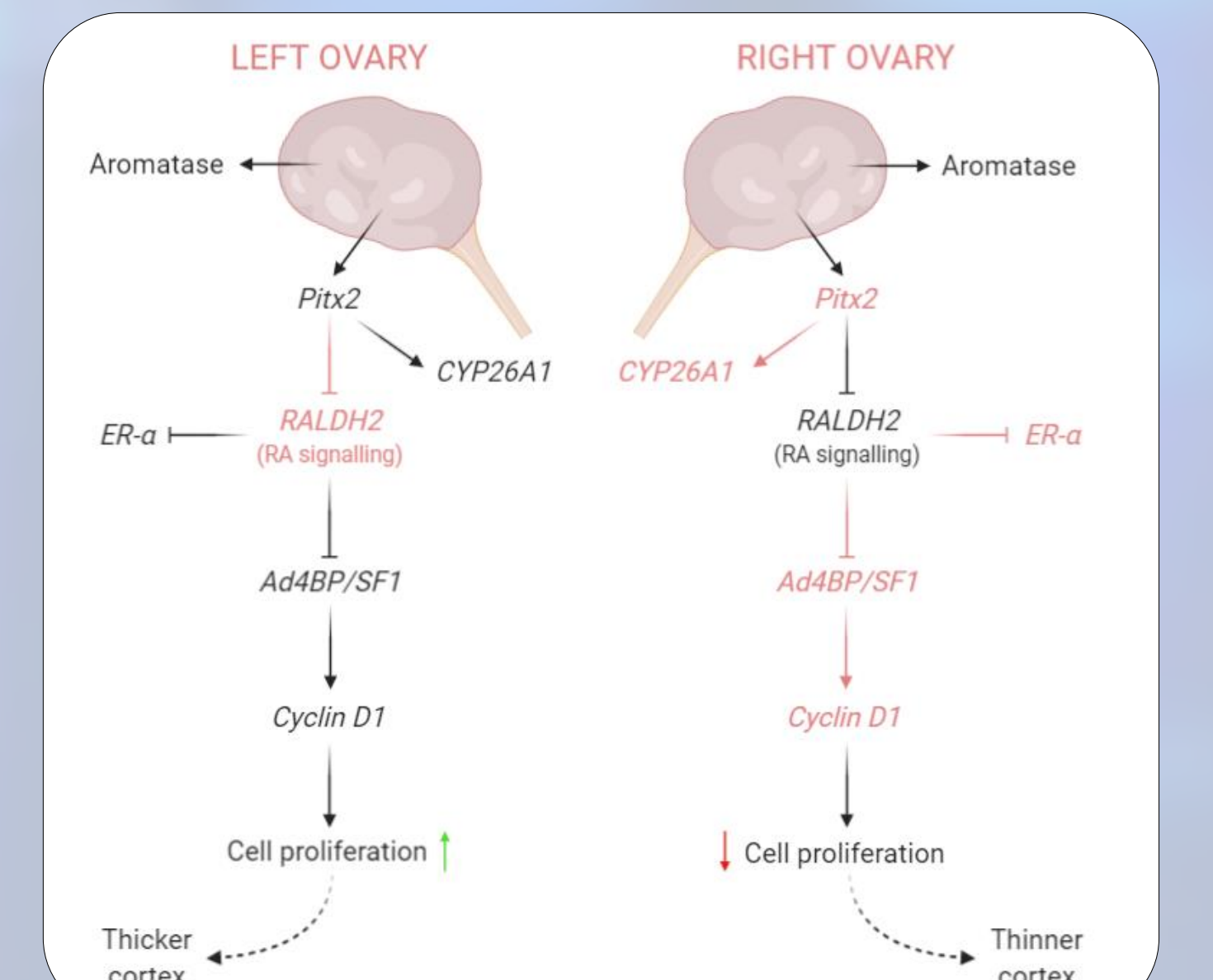


Figure 6. Asymmetrical gonad genes expression. Adapted from Y. Ishimaru et al., 2008.

3.3.3. Function

SPACE RESTRICTIONS

- Reduced body cavity
- Asymmetric positioning of other organs

WEIGHT REDUCTION

- Better ability to fly
- Related to 1 oviduct/1 ovary

SURVIVAL RATE

- Related to egg fragility
- Higher survival rate avoiding proximal eggs

Most accepted hypothesis, also seen in other egg-laying mammals like the platypus

3.3.4. Possible reversal & secondary sexual traits induction

Right ovary compensation of left malfunction

- Seen in males
- Right gonad would act as a "back-up"
- Important in seasonal breeding species

Secondary sexual traits

Determined by hormonal expression



5. RELEVANT BIBLIOGRAPHY

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